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Meijer

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[54] **METHOD FOR MACHINING METAL PLATE**

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[52] **U.S. Cl.** **72/179**; 72/182; 413/17; 83/885

[58] **Field of Search** 72/325, 250, 179, 72/182, 210; 413/17, 55; 83/885, 886

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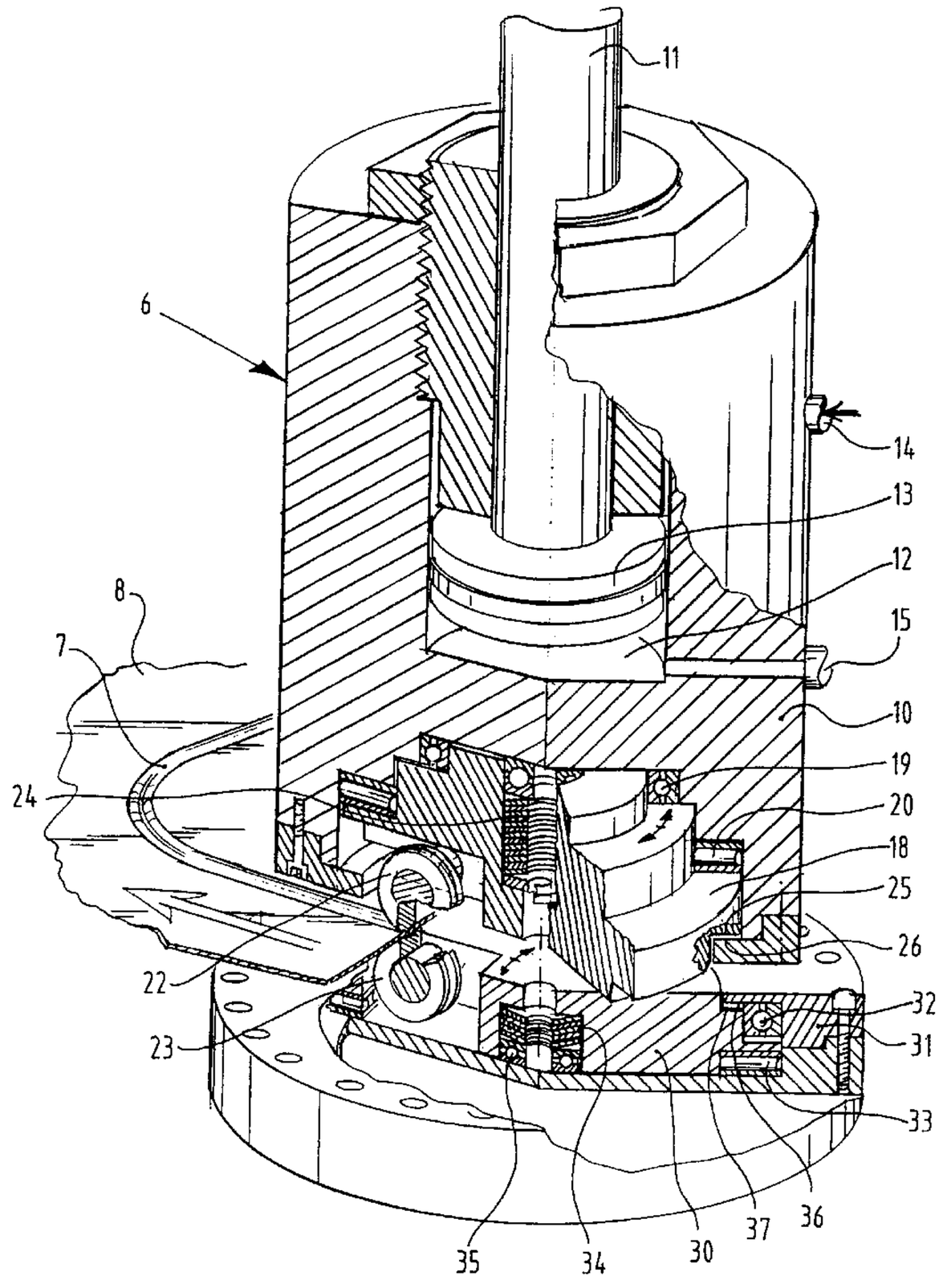
[57] **ABSTRACT**

The present invention relates to a method for forming weakenings in a metal plate **(8)**, comprising of: deforming the metal plate to a predetermined depth to form a weakening thinned portion along at least one line; and bending the metal plate along the line, characterized by displacing relative to each other the metal plate and at least one tool deforming the metal plate along the line and over at least one surface of the metal plate with a force directed substantially transversely of the metal plate and sufficient to deform the metal plate. The invention also relates to a device for performing thereof.

15 Claims, 4 Drawing Sheets



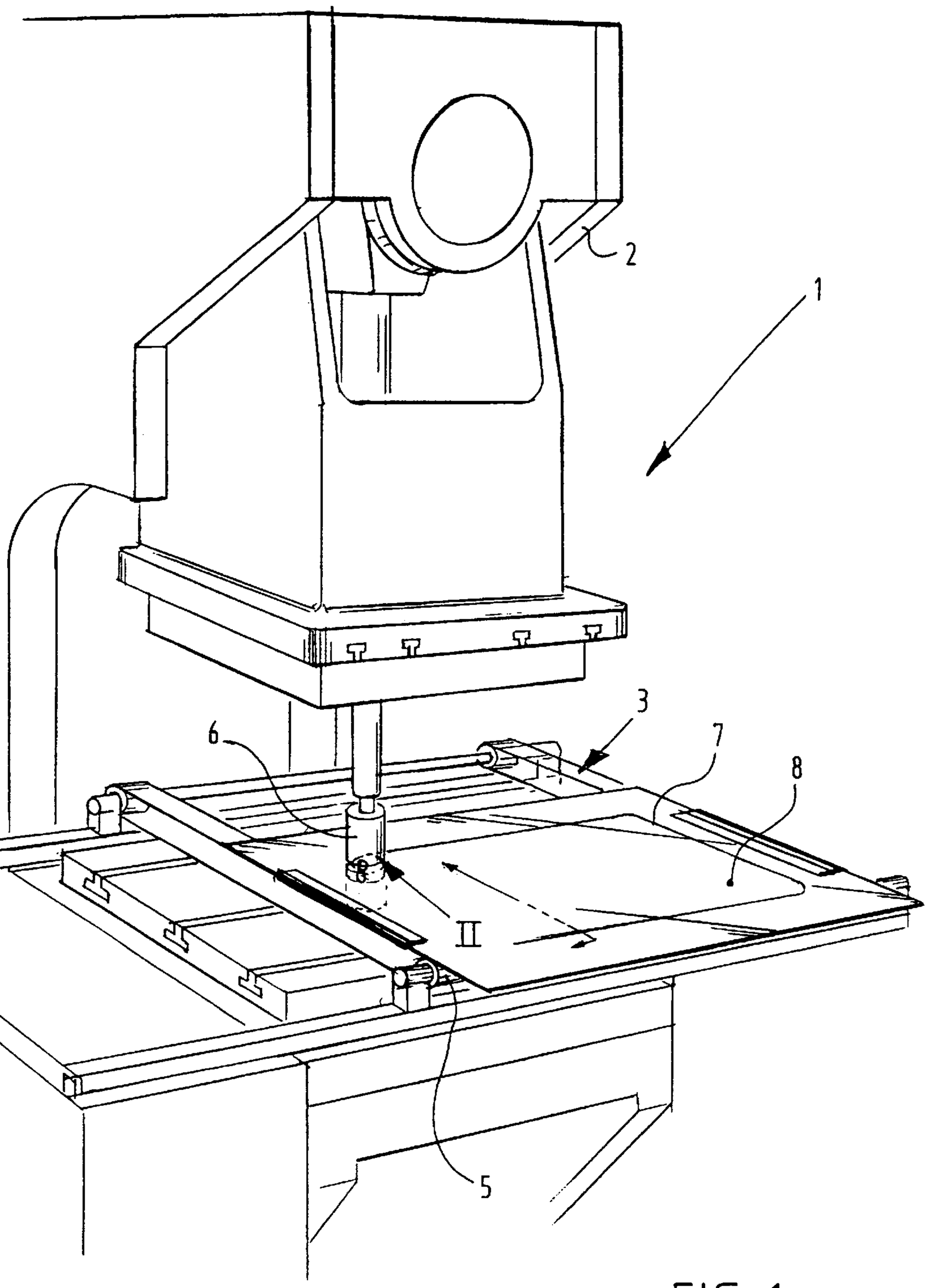
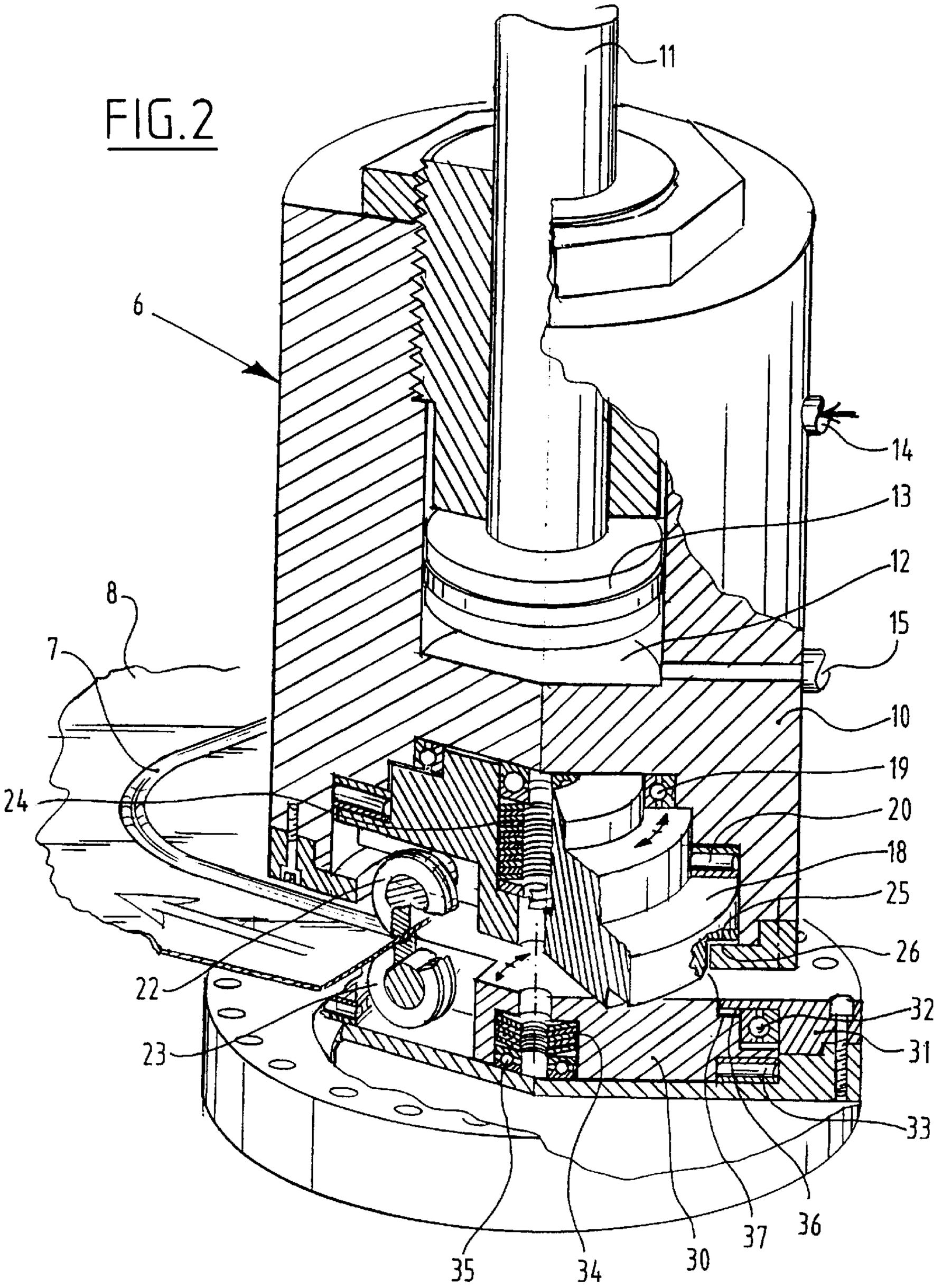


FIG. 1

FIG.2



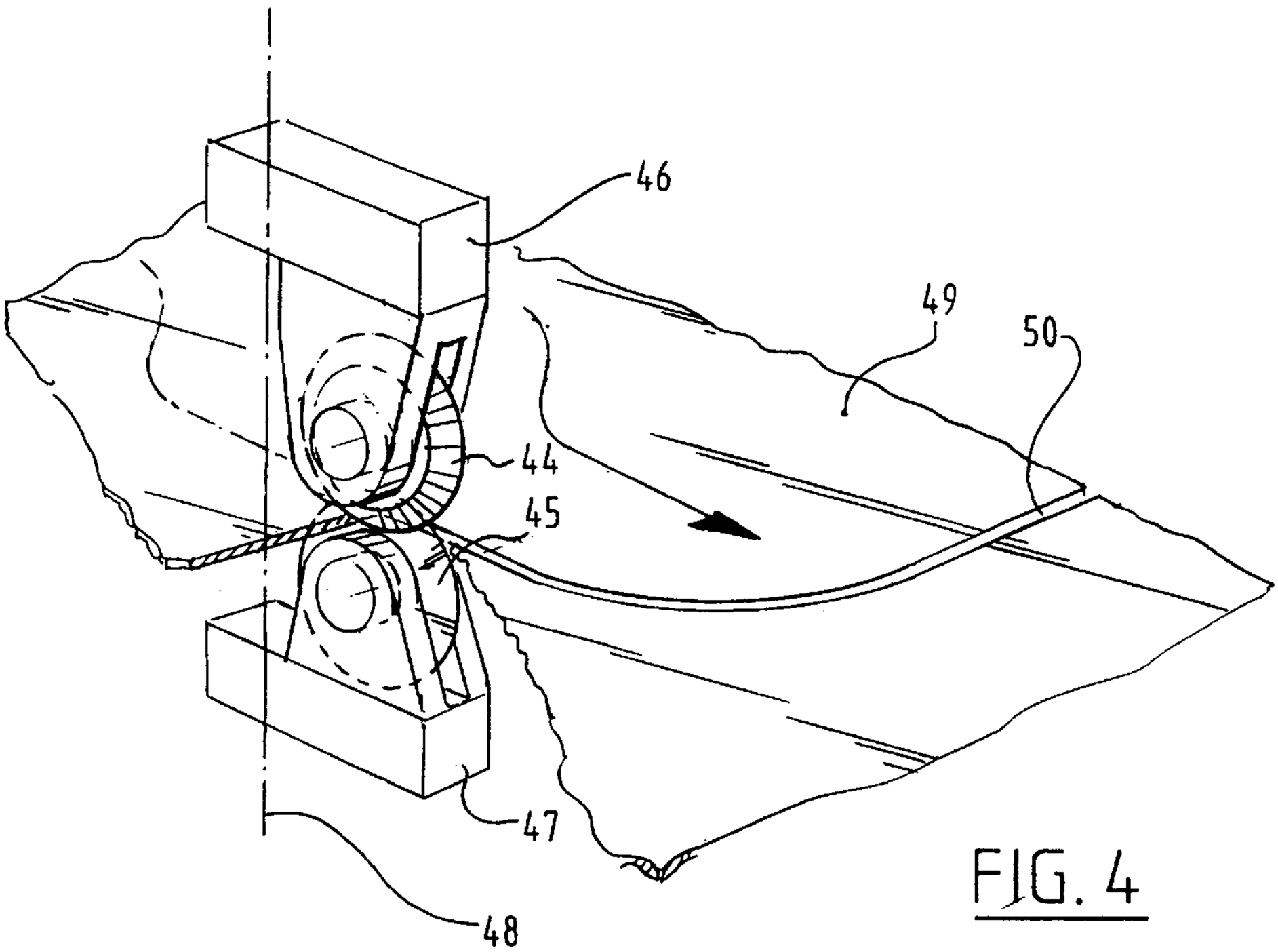


FIG. 4

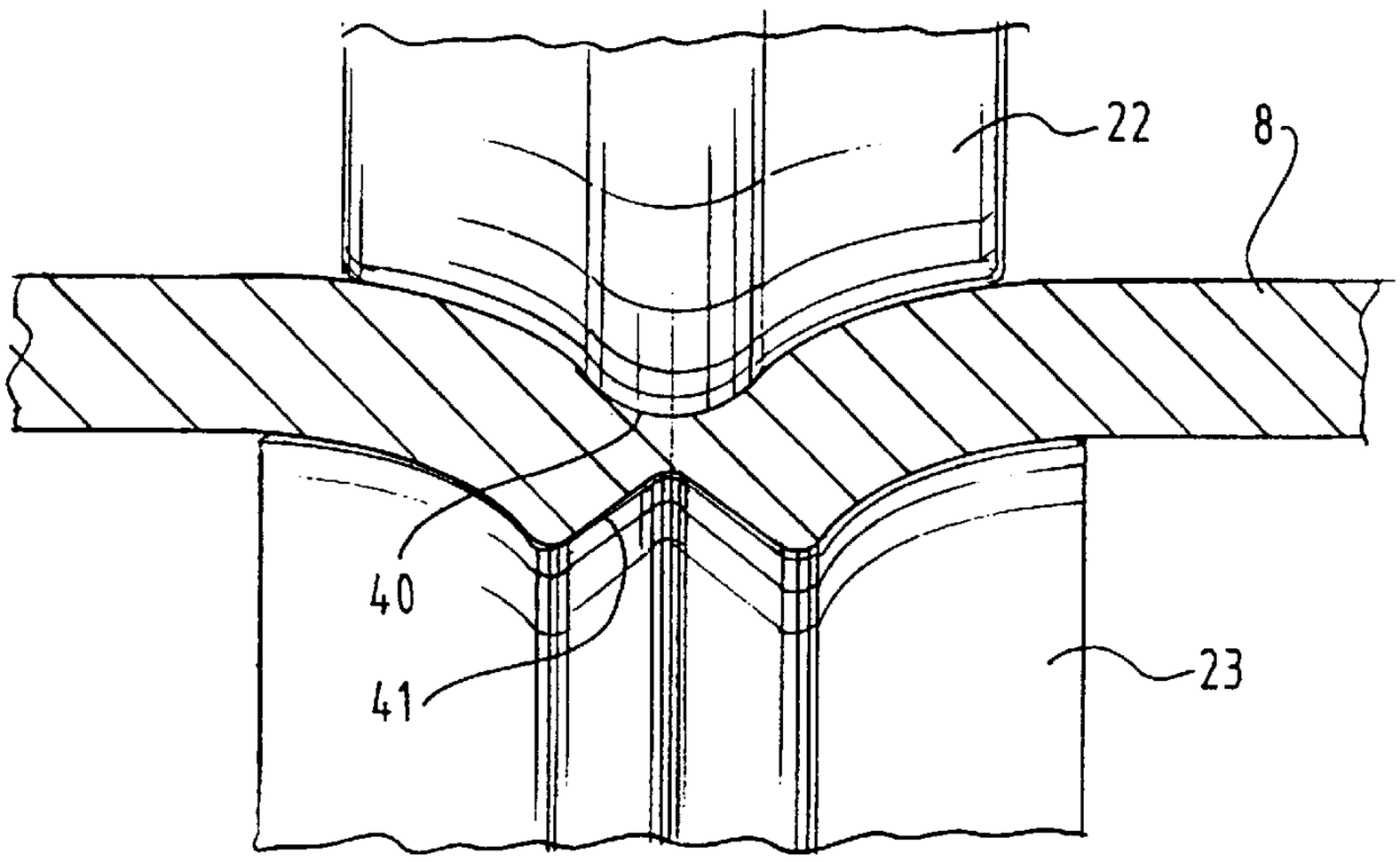


FIG. 3

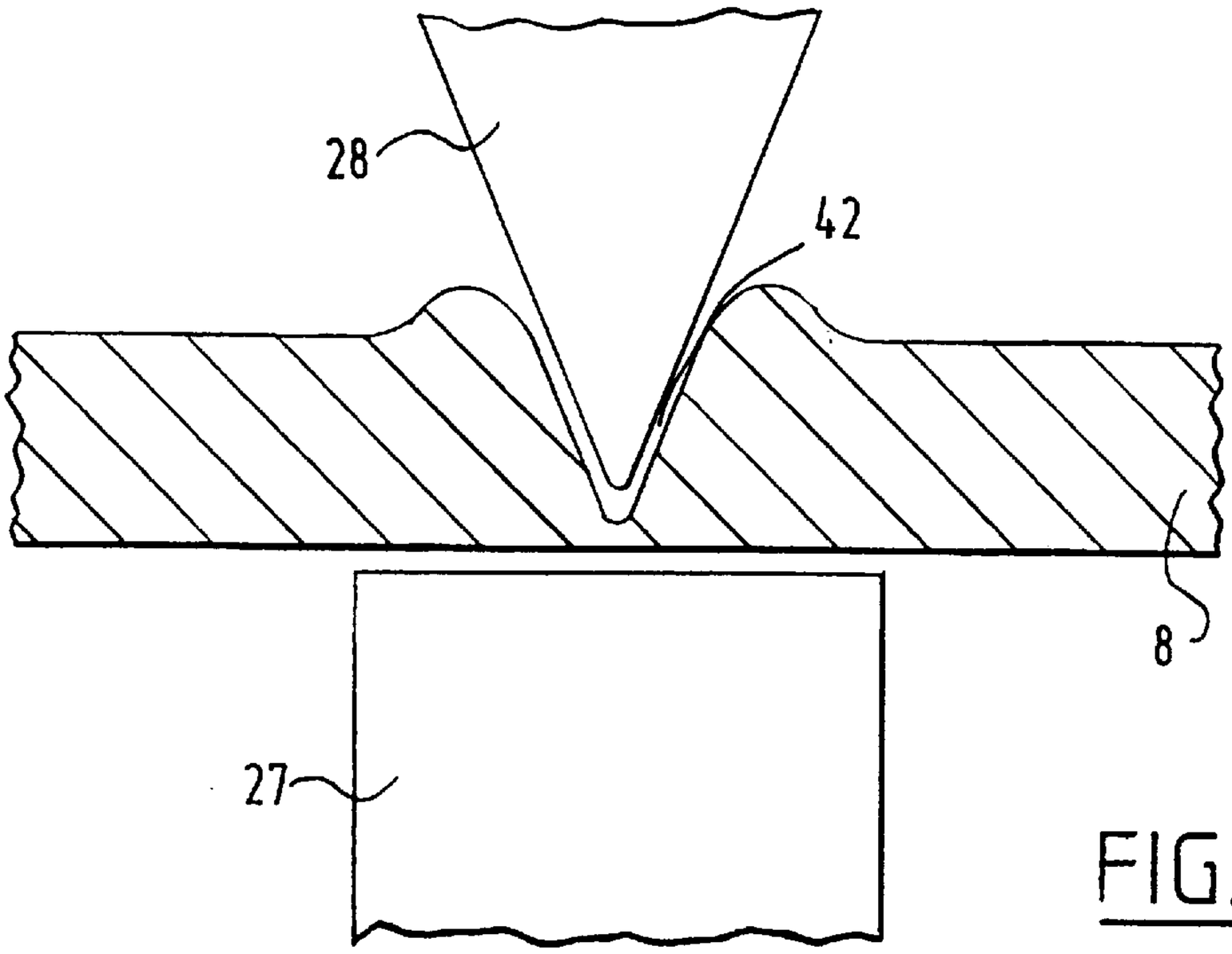


FIG. 5

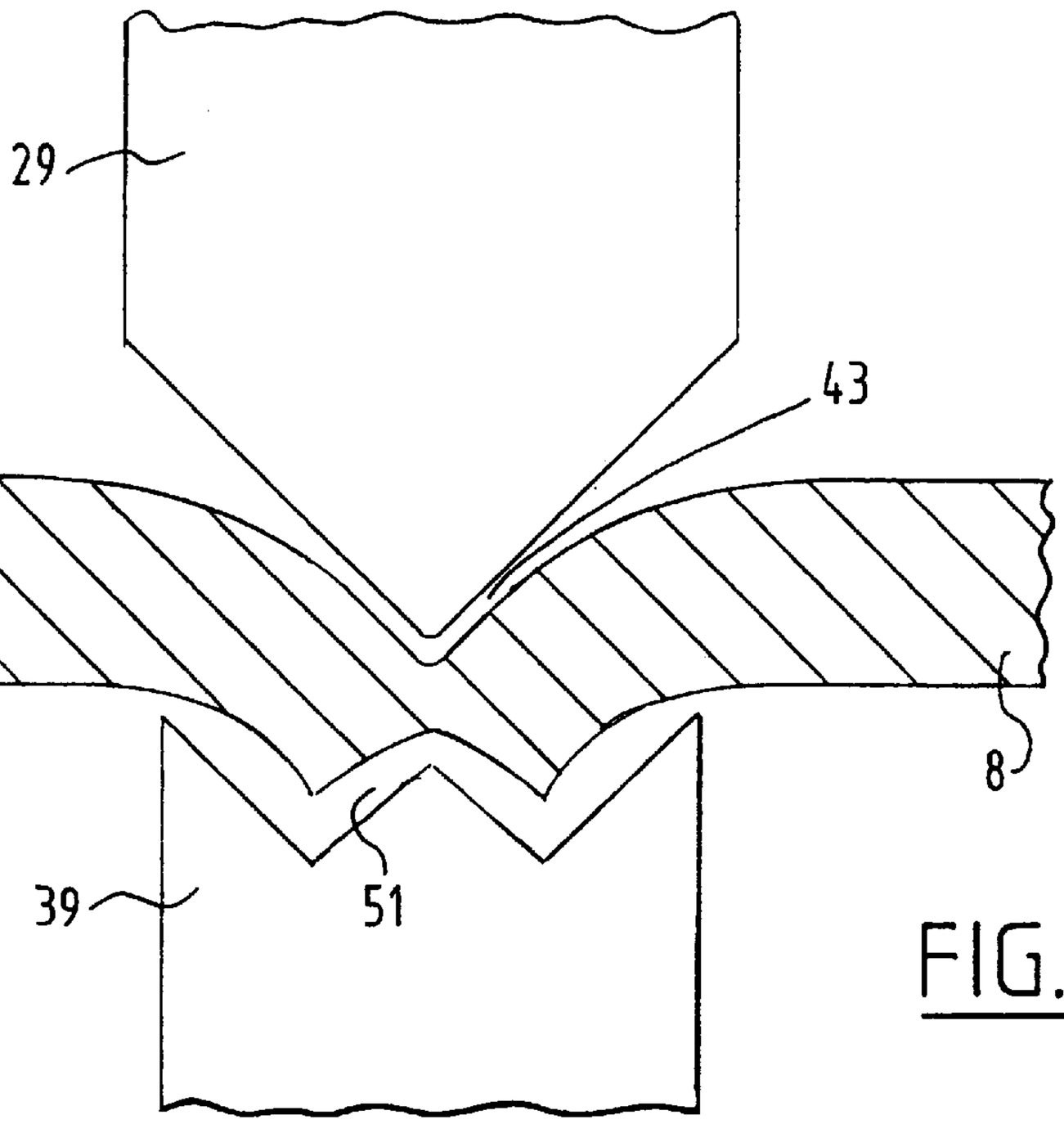


FIG. 6

METHOD FOR MACHINING METAL PLATE

This application is a 371 of PCT/NL97/00150, filed Mar. 25, 1997.

The present invention relates to a method and a device for forming weakenings in a metal plate. Particularly the invention relates to a method, comprising of:

deforming the metal plate to a predetermined depth to form a weakening thinned portion along at least one line to bend the metal plate along the line subsequent to the method; and

displacing relative to each other the metal plate and at least one pressure roller deforming the metal plate along the line and over at least one surface of the metal plate with a force directed substantially transversely of the metal plate and sufficient to deform the metal plate.

Such a method is known from the International patent application WO 95/19233, where the roller is ruled, punched, etc. into the material of the plate and the roller is placed centrally relative to a holder, to which the roller is connected. From this document also a device is known for machining metal plate, comprising: a frame; support means which are mounted on the frame and which define a supporting plane for a metal plate; at least one holder mounted on the frame and which is rotatable aroud an axis of rotation lying substantially transversely of the supporting plane, wherein the holder **25** carries a machining roller provided with a machining outer surface; moving means for displacing a metal plate on the support means relative to the holder. In the device the same considerations apply as hereinabove in relation to the method.

A disadvantage of the known device and the known method is, that in order to go through a tight turn in a line to be followed by the roller, e.g. a bend line, the process of following this line has to be interrupted, the roller has to be lifted from the plate and the holder, to which the roller is connected, has to be turned in order to redirect the roller in the desired direction, after which the roller can be brought back down on the surface of the metal plate. In this interruption alignment between the roller and the plate can change, whereby a resumption of the process may take place at another position than the end position of the machining prior to the interruption.

Moreover any interruption in automated machine processes is undesirable as a result of the loss of time that occurs and the complexity of the process, if it is interrupted frequently, increases to such an extent, that control of the processes is also complicated.

The invention has for its object to obviate at least an above mentioned drawback and provides for this purpose a method, which is distinguished by applying a swivel castor, having an axis of rotation, around which a pressure roller is rotatable, and a swivel axis, where the axis of rotation is essentially perpendicular to a swivel axis and where the swivel axis and the axis of rotation cross at a distance. Also according to the present invention a device is provided, which is distinguished in that the roller is mounted on the holder in a swivel castor configuration on a roller shaft crossing the axis of rotation at a distance.

According to the present invention it is possible to selectively pivot the pressure roller during displacement thereof. In this manner it is possible to weaken a metal plate by thinning along a straight and/or curved line with a very tight bend therein or at the end thereof. In preference however the method herein additionally comprises arresting the pivotability of the pressure roller when it is not in use, so that the pressure roller can be set into operation again in the same

position as that wherein the pressure roller was previously rendered inoperative such that arranging of a line can be continued after a short interruption without there being any difference in the position of the pressure roller and without any discontinuity in the form of the weakening along the line. Other advantages of arresting the pivotability are described hereinbelow in relation to the figures. This step alternatively comprises pivoting the pressure roller to a starting position when it is not in use. In this way a new line can be initiated from the same starting position each time. This is then preferably a starting position relative to a rotating station of for instance a punch press or nibbling machine in which the tool is placed, wherein the rotating station itself is mounted for rotation on other components of the punch press or nibbling machine so as to be able to rotate relative thereto and thus be able to carry the pressure roller into any random desired position relative to the plate prior to starting the machining.

In a second embodiment a method according to the present invention comprises the step of repeated and substantially adjacent punching of segments of the line in the plate. In this manner a practically continuous thinned portion is arranged along the line and it is possible in very efficient manner to pass through even acute angles in the line during following thereof for the purpose of arranging the thinned portion. In preference the method herein comprises punching the bend line using a punch press or nibbling machine, wherein the punch is struck repeatedly and substantially adjacently in the metal plate to thus arrange deforming thinned portions along the line. The method herein preferably comprises punching along the bend lines with a wedge-shaped stamp as punch in order to form a groove of wedge-shaped cross section in the metal plate.

In another preferred embodiment a method according to the present invention comprises the step of displacing the metal plate and a combination of at least two tools relative to each other, of the tools moving along the bend line over a surface of the plate, and at least one being a swivel castor. In this manner the plate is machined from the upper side and the underside thereof in order to form the weakening thinned portion. The weakening thinned portions can herein be located directly opposite each other in the metal plate, but can also be arranged mutually parallel along the line.

The present invention further comprises a device for performing a method according to the present invention, in addition to a plate manufactured with a method or device according to the present invention.

The invention will be further elucidated hereinbelow with reference to embodiments of devices for performing the method according to the present invention. In the drawing:

FIG. **1** shows schematically a device according to an embodiment of the invention,

FIG. **2** shows a detail as according to arrow II in FIG. **1**,

FIG. **3** shows a view as according to III in FIG. **2**,

FIG. **4** shows a detail of an alternative embodiment,

FIG. **5** shows a sectional side view of a plate in a first alternative device according to the present invention, and

FIG. **6** shows a sectional side view of a plate in a second alternative device according to the present invention.

In the figures the same components are referred to with the same reference numerals.

The device **1** shown schematically in FIG. **1** comprises a frame **2** on which are mounted support means **3** for supporting a metal plate **8**. In this schematic embodiment the support means **3** comprise a controlled X/Y drive **5**, with which metal plate **8** can perform random programmable translation movements relative to a tool holder **6** of device **1**.

The tool holder **6** comprises machining rollers to be further described with reference to FIG. **2**, with which a profile **7** can be arranged in plate **8**.

The actual machining tool is shown in FIG. **2** and comprises a holder **18** in which a first machining roller **22** is mounted and a holder **30** in which a second machining roller **23** is mounted. In device **1** the holders **18**, **30** are mounted such that roller **23** is supported beneath metal plate **8** and roller **22** is supported above metal plate **8**. Together they can form said profiling **7** in metal plate **8**.

Holder **18** is received in a housing **10** for rotation round a vertical axis. Formed in the top of housing **10** is a hydraulic cylinder **12** in which a piston **13** is slidable, said piston being connected to a shaft **11**. The housing **10** is mounted in device **1** with shaft **11**. Use can of course be made alternatively of a pneumatic cylinder instead of hydraulic cylinder **12**, or of other similar equipment.

Hydraulic cylinder **12** comprises two connections **14** and **15**. By feeding oil under pressure to connection **14** this oil is carried above piston **13**, whereby housing **10** moves upward relative to shaft **11**. By feeding oil via connection **15** oil is carried under piston **13**, whereby housing **10** is moved downward.

Holder **18** is mounted in housing **10** for rotation on said vertical axis by means of a radial ball bearing **19** In vertical direction holder **18** is enclosed in housing **10** in downward direction by means of a ring of housing **10** which engages beneath an edge of holder **18**. The thereby formed co-acting contact surfaces **25**, **26** on respectively holder **18** and housing **10** serve as arresting means for arresting holder **18** against rotation in housing **10**.

Holder **18** is in fact urged downward by spring washers **24** relative to housing **10**, i.e. toward the holder **30** located opposite. When housing **10** is moved upward, spring washers **24** will thus press contact surfaces **25**, **26** with force against each other, whereby holder **18** is received non-rotatably in housing **10**.

When holder **18** is pressed upward relative to housing **10**, in particular because housing **10** is pressed downward such that the roller **22** thereof is pressed via metal plate **8** against the underlying roller **23**, holder **18** will be moved slightly upward in housing **10** counter to the pressure of spring washers **24**, such that the contact surfaces **25**, **26** move apart and holder **18** becomes freely rotatable in housing **10**. Holder **18** is therein supported in axially upward direction by an axial bearing **20**.

The lower holder **30** is built up in substantially corresponding manner. Holder **30** is mounted rotatably in housing **31** by means of a radial ball bearing **32**. Here also holder **30** is loaded by means of spring washers **34** which rest on one side against holder **30** and on the other side against an axial ball bearing **35**.

When holder **30** can move freely upward under the influence of the force exerted by spring washers **34**, a peripheral edge **37** thereof comes into contact with a peripheral edge **36** which is fixedly connected to housing **31**. Holder **30** is hereby also arrested non-rotatably in housing **31**.

When holder **30** is pressed downward in housing **31** counter to the force of spring washers **34**, in particular because the upper machining roller **22** presses via metal plate **8** on the lower machining roller **23**, the contact surfaces **36**, **37** move apart, whereby holder **30** becomes freely rotatable in housing **31**. The axial load on holder **30** can herein be absorbed by axial bearing **33**.

As is clearly shown in FIG. **2**, the machining rollers **22**, **23** are mounted rotatably on roller shafts which intersect at a distance the axis on which holders **18**, **30** are jointly rotatable.

When holder **10** is now pressed downward because oil under pressure is introduced under piston **13** via connection **15**, metal plate **8** is clamped between machining rollers **22**, **23** and the respective contact surfaces are released, whereby holders **18**, **30** become freely rotatable.

When plate **8** is now displaced relative to the holders, the rollers **22**, **23** will roll over plate **8** and therein press for instance a groove into plate **8**. When plate **8** moves through a curved line relative to holders **18**, **30** the rollers **22**, **23** will cause holders **18**, **30** to rotate due to a swivel castor effect, whereby rollers **22**, **23** roll evenly in the curved path over plate **8**. Holders **18**, **30** do not therefore have to be rotated in controlled manner. Simply as a result of the relative displacements of metal plate **8** the holders **18**, **30** adjust to the desired angle, wherein the transverse plane of the rollers **22**, **23** extends parallel to the tangent to the described path.

When a machining with rollers **22**, **23** is completed, i.e. when for instance the end of the groove to be formed has been reached, housing **10** is moved upward by supplying oil under pressure via connection **14**. The spring washers **24** and **34** subsequently press holders **18** respectively **30** with their contact surfaces **25** respectively **37** against the oppositely located contact surfaces **26** respectively **38** of housings **10**, **31**, so that these holders **18**, **30** are arrested against rotation. At the next machining, i.e. at the beginning of a following groove to be formed, when housing **10** is moved downward to press wheels **22**, **23** with force toward each other, these wheels **22**, **23** will thus be positioned accurately relative to each other, in accordance with the positioning they had at the end of the previous machining. No separate means are therefore required to align holders **18**, **30** relative to each other.

FIG. **3** shows in more detail a possible embodiment of rollers **22**, **23**, wherein the co-acting outer surfaces of rollers **22**, **23** are formed such that in the top surface of plate **8** a groove with gradually rising walls is formed, while in the underside of the plate a W-shaped groove is formed with likewise gradually rising walls. Such a profiling of plate **8** enables bending of the plate at the position of the grooves, wherein a uniform external rounding is obtained in the bent form. This also brings about centering of the two rollers **22** and **23** relative to each other on either side of the plate.

With the device according to the invention other rollers can also be used in addition to machining rollers such as machining rollers **22**, **23** to press a special profile in the metal plate. FIG. **4** shows schematically an application wherein rollers **44**, **45** are co-acting cutting rollers for arranging a cut **50** in plate **49**. Rollers **44**, **45** are here likewise mounted in holders **46**, **47** which are rotatable round a common axis **48**. The axes of rotation of rollers **44**, **45** intersect this axis **48** at a distance, so that the desired "swivel castor action" is realized.

The co-acting machining rollers do not necessarily have to have substantially complementary profilings. When a groove has to be arranged in a metal plate, only the upper roller may for instance be provided with a radial protrusion, while the lower roller takes a wholly flat form. Other suitable profilings of course lie within the reach of the skilled person in the field.

As stated above, the device according to the invention can suitably be a punch press or nibbling machine. Housings **10**, **31** are herein mounted for instance in co-acting stations of tool holders. The metal plate **8** is moved by the X/Y drive of the machine along a preprogrammed path relative to rollers **22**, **23**, wherein the desired machining will thus take place along this path by the outer surfaces of rollers **22**, **23**.

It will be apparent herein that the path for the movements to be performed, which is to be programmed in the usual

manner, is not exactly the path which is described by rollers **22**, **23** relative to metal plate **8**. The path to be programmed defines the position of the central axis of housings **10**, **31** relative to metal plate **8**, while the contact location of rollers **22**, **23** lies at a distance therefrom. It is however simple for any skilled person in the field to appreciate how the programming of the movements of the device must be performed in order to cause the machining to take place according to a desired path in metal plate **8**.

In the device according to the invention the holders can also be mounted in suitable manner for controlled rotation in the device, so that they can be placed at the suitable angular position each time a machining is initiated. This particularly applies in the case of a punch press or nibbling machine when the housings with the holders mounted therein are accommodated in a rotating station of this machine. All the required control means for placing the holders in the desired angular position are then already present in this machine.

It is noted that although in the described preferred embodiment the pressing force for pressing the machining rollers toward each other is generated in the tool itself, by means of the piston/cylinder construction, this force can of course also be generated in the machine itself, wherein the tool can thus take a simpler form.

FIG. **5** shows a cross-sectional view of a plate **8** for machining and a punch press or nibbling machine, of which only a punch designed as a stamp **28** and a support block **27** are shown. Stamp **28** and/or support block **27** are preferably arranged in a rotating station of the punch press or nibbling machine, wherein this rotating station is preferably also rotatable relative to the other components of the punch press or nibbling machine. This enables adjustment of the stamp in random positions relative to the plate and/or the other components of the punch press or nibbling machine.

Support block **27** and stamp **28**, which has limited dimensions in the longitudinal direction of the line along which plate **8** is later folded, each form part of the punch mechanism, the other parts of which are not shown here. Support block **27** and stamp **28** are situated practically in the extreme position thereof during a stroke of the punch press or nibbling machine wherein a groove **42** is arranged in plate **8**. At each stroke of the punch press or nibbling machine a segment of the groove **42** is formed along the line under the deforming influence of substantially the stamp **28** during the stroke. The plate is then shifted, wherein a side edge of stamp **28** abuts in longitudinal direction of the line and on the rear thereof relative to the direction of displacement to the end of the groove **42** formed up to that point, or overlaps it, whereafter a new stroke is started.

Support block **27** is designed in this figure as a counter-stamp moveable in a direction opposed to that of stamp **28**, but can alternatively be formed by a stationary support surface or the like. It is also possible for the support block to comprise a separate stamp with a form corresponding with that of the stamp **28** at the top of the figure and in an opposing direction.

FIG. **6** shows a cross section corresponding with FIG. **5** of plate **8**, which is however machined with an alternative punch press or nibbling machine. The punch press or nibbling machine shown here comprises a punch mechanism with a drive (not shown) and an alternative, blunter stamp **29** as punch. A groove **43** formed with this stamp **29** is therefore wider on the surface of plate **8** shown at the top than the groove **42** shown in FIG. **5** formed with the sharper punch **28**.

The device here also comprises a counter-stamp **39** as in the situation shown in FIG. **5**. The counter-stamp **39** does however have the same W-shape as the outer surface of the roller **23** shown in FIG. **3**. With this counter-stamp **39** a second groove **51** is formed in the surface lying opposite groove **43**. In terms of the effects hereof, the same applies as already noted in respect of FIG. **3**.

In contrast to the situation shown in FIG. **3**, where rollers **22** and **23** are displaced over the surface of plate **8**, stamp **29** and counter-stamp **39** make a stroke and are subsequently displaced along the line along which plate **8** is later bent, this over a distance corresponding to the width of at least the stamp **29**, in order to abut at the following stroke onto the groove **43** formed up to that point, or to overlap to a certain extent the end thereof in longitudinal direction of the line.

As already remarked in respect of FIG. **5**, it is also the case for FIG. **6** that stamp **29** and counter-stamp **39** are shown in practically extreme positions thereof. The depth to which the grooves respectively **42**, **43** formed with stamps **28** and **29** extend is predetermined. A number of means may be used for this purpose. One of these is the use of arresting which acts mechanically on stamps **28** and **29** and/or on counter-stamps respectively **27** and **39**. The arresting, for instance a cam (not shown) engaging stamps **28** and **29** and/or counter-stamps respectively **27** and **39**, herein makes impossible a deeper penetration into the material of plate **8** than is shown here in FIG. **5** and **6**. Alternatively, the punch mechanism, of which only stamps **28** and **29** and counter-stamps respectively **27** and **39** are shown and not the drive therefor, is provided with a control for adjusting a striking force of the stamps to be generated by the drive. Many other possible alternatives of the arresting will be apparent to a skilled person on the basis of the foregoing description thereof. The same applies for the method and device according to the present invention.

I claim:

1. Method for forming weakenings in a metal plate, comprising of:

deforming the metal plate to a predetermined depth to form a weakening thinned portion along at least one line to bend the metal plate along the line subsequent to the method; and

displacing relative to each other the metal plate and at least one pressure roller deforming the metal plate along the line and over at least one surface of the metal plate with a force directed substantially transversely of the metal plate and sufficient to deform the metal plate, characterized by

applying a swivel castor, having an axis of rotation, around which a pressure roller is rotatable, and a swivel axis, where the axis of rotation is essentially perpendicular to a swivel axis and where the swivel axis and the axis of rotation cross at a distance.

2. Method as claimed in claim **1**, characterized by arresting the pivotability of the pressure roller when it is not in use.

3. Method as claimed in claim **1**, characterized by pivoting the pressure roller to a starting position when it is not in use.

4. Method as claimed in claim **1**, characterized by repeated and substantially adjacent punching of segments of the line in the metal plate.

5. Method as claimed in claim **1**, characterized by punching the line using a punch press or nibbling machine.

6. Method as claimed in claim **4**, characterized by punching along the lines with a wedge-shaped stamp.

7. Method as claimed in claim **1**, characterized by displacing the metal plate and a combination of at least two tools relative to each other, each of the tools moving along

the bend line over a surface of the plate, and at least one being a swivel castor.

8. Device for machining metal plate, comprising: a frame; support means which are mounted on the frame and which define a supporting plane for a metal plate; at least one holder mounted on the frame and which is rotatable aroud an axis of rotation lying substantially transversely of the supporting plane, wherein the holder carries a machining roller provided with a machining outer surface; moving means for displacing a metal plate on the support means relative to the holder, characterised in that the roller is mounted on the holder in a swivel castor configuration on a roller shaft crossing the axis of rotation at a distance.

9. Device as claimed in claim **8**, where the holder is freely rotatable on the axis in a machining position.

10. Device as claimed in claim **8**, comprising arresting means for arresting the holder in a rotation position.

11. Device as claimed in claim **9**, wherein the holder is axially displaceable along the common axis in order to enable displacing of the machining roller between a machining position proximal to said supporting plane and a rest position distal from said supporting plane and the arresting means enter into operation when the roller is moved from the machining position into the rest position.

12. Device as claimed in claim **11**, wherein the holder is mounted on a housing for axial displacement and for rotation around the axis, the arresting means comprise co-acting contact surfaces on the housing and the holder which, in an end position of the holder proximal to the supporting plane come into engagement and the holder is urged by biasing means in the direction of the supporting plane.

13. Device as claimed in claim **12**, wherein the biasing means comprise spring-mounted means.

14. Device as claimed in claim **12**, wherein the spring-mounted means comprise spring washers.

15. Device as claimed in claim **8**, wherein the holders are arranged in co-acting tool carriers of a punch press or nibbling machine.

* * * * *